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ABSTRACT

This instructional unit is one of 10 developed by students on various energy-related areas that deals specifically with agricultural energy practices. Its objective is for the student to be able to discuss energy use and conservation of resources in the production of agricultural products. Some topics covered are basic uses of direct energy in agriculture production, factors concerning energy efficiency in agriculture production, benefits that energy subsidies to agriculture production make possible to the national economy, and reasons for the substantial increase in production yields in United States agriculture. Material in each unit may include some or all of the following: terminal and specific objectives, list of references, information sheet with terms and definitions, informative materials, transparency masters, assignment sheet(s), and unit test with answers. (YLB)

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AGRICULTURAL ENERGY PRACTICES

by

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AGRICULTURAL ENERGY PRACTICES

TERMINAL OBJECTIVE

Upon completion of this unit the student will be able to discuss the energy use and conservation of resources in the production of agricultural products. Proficiency will be evidenced by a recommended 85% on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit the student will be able to:

1. Identify general factual statements concerning agricultural production from non-factual statements.
2. List four of the basic seven uses of direct energy in agriculture production.
3. Select factors concerning energy efficiency in the production of agricultural products in the United States.
4. Identify the benefits that energy subsidies to agriculture production make possible to our national economy.
5. List several factors that are major reasons for the substantial increase in production yields in United States agriculture.

AGRICULTURAL ENERGY PRACTICES

INFORMATION SHEET

I. Terms and Definitions

A. Agricultural Mechanization -- use mechanical devices in utilization of economic resources for agricultural production.

B. Aquaculture Production -- farming system that occurs in reefs and marshes to produce food products.

C. Bio-mass -- solid waste from crop production and animal waste used in fuel production.

D. Chemicals, Agricultural -- combinations of chemical substances used to eliminate pests and diseases.

E. Contour, Farming -- following the contour lines of uneven terrain to limit erosion of topsoil.

F. Crop Rotation -- movement of crops from one section or field to another in a rotation.

G. Fertilizer(s) -- natural and synthetic materials worked into soils to increase its fertility.

H. Hybird -- the off spring produced by breeding plants or animals of different varieties or species.

I. Insecticide(s) -- chemical agents used to kill insects and similar pests.

J. Irrigation -- to supply land with water by means of ditches, pipes, streams or mechanical devices.

K. Nitrogen -- a non-metallic element containing mostly air used in manufacture of fertilizers.

L. Photosynthesis -- process by which light from the sun is transformed into chemical energy in green plants and oxygen is released.

M. Protein -- organic compounds that are essential for growth and repair of animal tissue.

N. Solar Energy -- thermal or electric energy produced by conversion of light rays from the sun.

O. Synthetic -- components not of natural origin and man made.

P. Tillage -- the cultivation of land for croping.

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AGRICULTURAL ENERGY PRACTICES

Early agricultural systems developed by mankind used simple tools for the cultivation of land and domestication of animals. Much hard labor and time was required. Later, as technology improved and harnessing of the energies of animals, water and wind for agricultural work, the time and individual efforts eased.

This change in the agricultural activity of humans allow for the movement of people to one place and the concentration of agriculture in another. When the industrial revolution developed the area of agricultural production received powerful new tools.

Therefore, mankind moved from using agriculture for feeding himself to the supplying of food for population centers. The exportation of products of farming has now gone beyond the fence rows to points all over the world.

The original purpose was basically to capture the solar energy of the sun and convert this energy through plants or animals using those plants to achieve further production. This process is called photosynthesis and is only about 1% efficient in converting the total solar energy received. The changing needs of mankind, industrialization, and the emerging use of fossil fuels all had a deep affect on agriculture.

Although over 90% of the energy going into the production of plantlife is the solar energy mentioned, the others are also important. Modern agriculture is an energy intensive or primary user of fossil fuels. Agriculture production is not an excessive user of fuels, however, in light of contributions from agriculture to

mankind from the energy inputs overall.

Only 5% or less of the United States population is directly involved in farming. Over 50% of farmers hold some kind of off-the-farm job and with this small number of workers vast production has been achieved on America's farms.

The influence of energy input use has had on production of crops and livestock is amazing. The work of the farmer has been multiplied many times by power driven machinery. It is estimated that one farmer's production now feeds over 50 other people on the average. The decrease in farm labor during the last half century was made possible mainly by use of more energy.

Production agriculture uses just under twenty percent of the total energy of the entire food system. The food system is made up of all the remaining parts of what it takes to make food available beyond the farmstead. This includes processing, packaging, transportation, wholesale and retail trade plus final in home or institutional preparation. This subject is dealt with in another unit, "Food System Use of Energy".

The total use of energy by production agriculture is less than three percent of the gross energy consumption in the United States.

The related inputs of fertilizer, chemicals nutrients and other related products also consume energy in their production and transport to be used on the farmstead. We can understand that the producer, although not using much man-hour labor, uses many kinds of products and services requiring energy use beyond that used on the farm.

The most significant assistance the farmer has received in boosting productivity besides power mechanics has come from three

main areas. The development of hybird seeds, inorganic fertilizer and modern pest controls. In some parts of the nation the advance methods of bringing water to the point of use via irrigation is also very significant.

Food exporting capabilities have increased substantially because of the use of energy and the related resources mentioned. Farm exports now contribute to over thirty percent of the gross income of farmers. Most of this income is from the exporting of grains. Little of the farm production is processed to any degree when exported. The income from farm production to the national economy is more than the farm income in total.

The use of energy for increasing the technological ability of production agriculture to increase productivity will continue. However, increased energy input will not further increase the food production beyond present levels. Different techniques and practices may be required to achieve more productivity without using more energy in direct proportion to output.

Because of the limits now placed on economic use of energy inputs to produce a larger proportion of increased productivity, some alternative should be considered. Some conservation of resources practices are being followed.

Minimum tillage methods have been increasing rapidly. The methods combine the operations previously done in several passes over the field with specialized equipment. Some crops such as corn and soybeans can be produced by as little as four trips over the field plus harvesting. The immediate advantage is the use of less

fuel both in less number of equipment passes and the use of equipment. Recommendations are to never set equipment, like the disk, lower than necessary. Never work fields when they are wet. Leaving residues in the field helps stop erosion and combining these practices increases comparative yields, decreases cost and saves energy. In summary, tillage operations can be combined in one implement for disking, plowing, and weed control to accomplish planting, fertilizing and herbicide application in untilled soil. Not only is fuel saved but machinery cost as well since energy is used in its manufacture.

The success of minimum tillage programs is the ability of control of weeds. The key to this objective is the proper use of herbicides, their availability, soil types to be applied and cost of machinery.

The major advantages of minimum tillage are:

1. Fewer trips across the field use less fuel.
2. Less time spent in field preparation saves labor costs.
3. Less soil compaction occurs because of small number of trips.
4. Field cover means less chance of erosion.

Better utilization of equipment by the farming sector as a whole would be beneficial. More emphasis should be given to use of combined equipment as mentioned in minimum tillage and also the cross utilization of expense to manufacture and maintain harvesting equipment. Farmers have participated in cooperative ventures for decades and could successfully cooperate on the use of all kinds of specialized machinery.

Land management is as equally important to energy savings as cultivation and equipment usage. The development of agricultural prime farm land to non-agricultural purposes cost more than the lost productive ability. The "asphalting" of America refers to covering of our prime land with commercial and domestic living areas. This means that potential marginal productive land must someday be used to replace the areas covered. Many states now have laws that give estate and other tax advantages to holders and heirs of land who are agriculture producers or in some way committed to keeping the land in production as adversed to speculative investment.

Irrigation and the methods utilized to move water from deep in the ground to the point of application are increasing users of energy. The cost of irrigation in some midwest areas has reached the level of over 35% of the agriculture energy input total cost. Land has been put into use that requires excessive input of energy related resources. Water is or soon will be pumped from too deep and for longer distances than is energy economically proper.

The use of water more abundantly has caused, among other reasons, the increased use of inorganic fertilizers. The shift from organic to inorganic fertilizer occured because of the reduced labor, ease of use, productivity, and specialization in farming. The comparisons between organic and commercial or conventional production are quite similar. However, the scale of production, labor requirement, land area required, and change in farming practices are not suitable for today's production expectations. The major difference that we find in our conventional methods of production

are the large quantities of product with efficient use of labor and technological equipment.

The most important area of energy use in fertilizer is the raw materials and base stocks used in manufacturing. Nitrogen fertilizers are used more than any other type. The production of nitrogen involves a process that uses not only natural gas to power the manufacturing process but large amounts of the gas additionally in nitrogen. The second most important nutrient to modern agriculture after nitrogen is phosphate. The product comes from the mining of phosphate rock which is in limited supply. It will increase in cost rapidly in the future.

In view of the use and supply situation in the two basic nutrients the utilization of these inputs should be the most productive possible.

The use of chemicals to kill pests of all kinds has been a major factor in increasing the productivity of modern agriculture. The use of herbicides in United States agriculture has increased more rapidly than any other kind of chemical pesticide. They have replaced the mechanical weed removal in most major crops. There are controversities concerning the environmental impact of chemicals and their role in productivity of our food and fiber. Large amounts of fossil fuel energy is saved through the unneeded mechanical cultivation they replaced. Some alternative methods are available but are energy costly - tillage, crop rotation, mixed cropping and fallowing of land.

The improvement of energy efficiency in mechanized agriculture could be accomplished in several additional ways. Shifting of

emphasis on range-fed beef instead of large present commercial concentrated feed lots and the use of more energy efficient foods in the American diet are two improvements. Soybeans are used in many parts of the world as protein. Most of the protein in the United States is conversion from the feeding of livestock feed grains to obtain meat, milk and eggs. Therefore, more energy is expended to produce these high protein foods than to produce a plant food like soybeans. The soybean has an excellent future as a worldwide source of food.

A major alternative to conventional energy use is the application of solar. Farmers have long used the sun to aid them in their work beyond the photosynthesis process. Solar heat has been practiced for years by farmers - open front livestock buildings facing the south for the sun's exposure, use of fiberglass roofed and sided buildings to increase heat for drying grain and hay, attic circulation of heat to livestock facilities and many more.

Combinations of solar heat and the movement of air to needed areas of warmth are providing many innovative methods to utilize solar. Because of the tendency to leave crops in the field longer in the fall to prolong yield time, more moisture accumulates.

The use of solar heat is very efficient to complete the drying process when the grain has reached a storable level. Systems using silos for collector mountings and then a plenum chamber connects through ducts to a drying bin. Small fans are used in the bin to pull the warm air from the plenum chamber. Most farmers can cut drying cost in half and pay for solar collection and distribution system in less than two harvest periods.

One system uses greenhouse grade fiberglass panels on a structure to dry hay bales of the large round variety. The actual drying is accomplished by turning the bales up on end and forcing the solar heat by fans through them. Bales are cut at 40% moisture and reduced to 15% level in three days in this facility. Tests have shown that milk cows produce better than with conventionally dryed hay on this type hay. Protein values of the hay is retained almost 90% since this method allows for cutting when hay is at high moisture without high drying cost.

The most important features of air and solar assisted drying is the ability to finish or complete the drying process of hay and/or grain in conjunction with high energy related methods. This makes the use of industrialized technology more efficient.

The storage of grain at the proper time of the drying process involves the proper readings be taken. Moisture content and temperature determination is a vital management practice regardless of what type of energy source is used in drying. Here are a few tips on energy savings for drying:

1. Harvest grain as dry as possible.
2. Harvest as clean of foreign matter as possible.
3. Prevent any air leaks in drying system since air will follow path of least resistance.
4. Fill grain bins uniformly to eliminate concentration of fines.
5. Maintain a level grain surface in storage.
6. Adjust the dryer burner regularly for best air-fuel mixture for efficient combustion.
7. Visually inspect for condensation, temperature and moisture at periodic regular intervals.

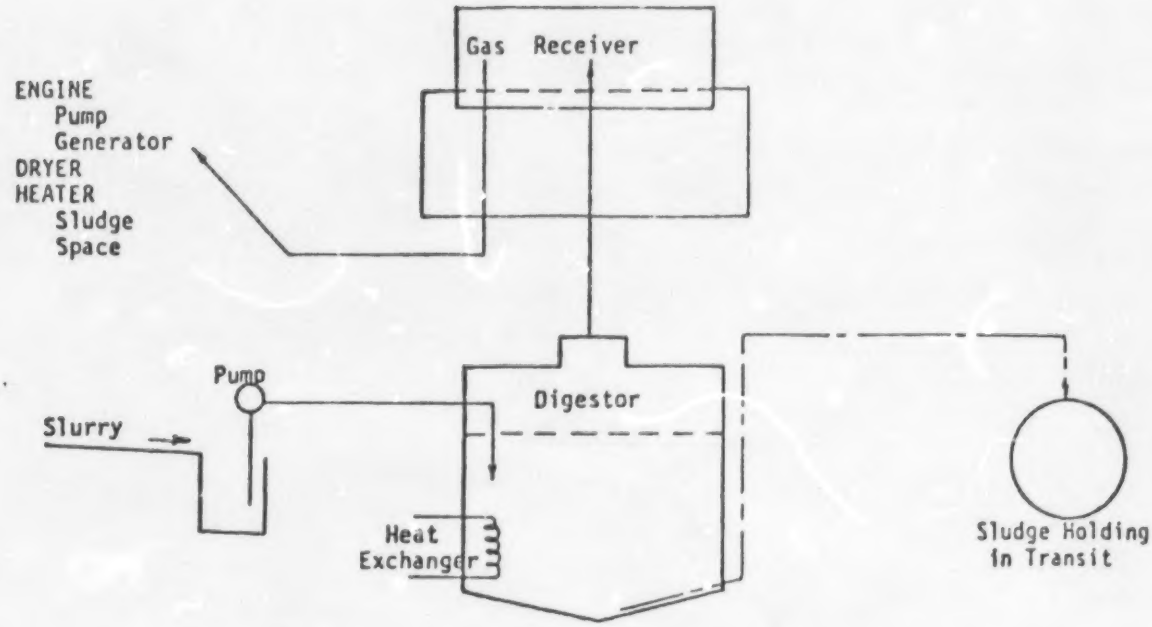


Fig. 1 The Bio-conversion System.

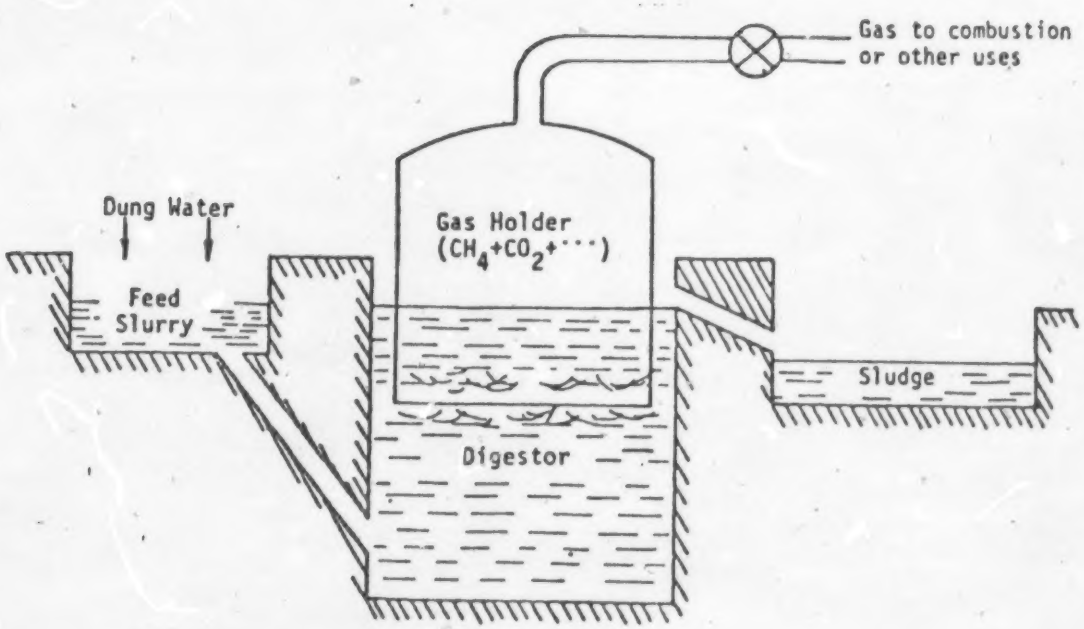


Fig. 2 Schematic Of A Biogas Plant.

Rising cost of energy used in the field of agriculture has generated the interest on increased production of methane gas. Methane gas is produced from the digestion of animal waste. A methane installation is also a very good method of waste treatment and removal.

Brogas is the proper name for the organically derived gas produced. An anaerobic digester converts the manure from animals. A diagram of a bio-conversion system is shown in Figure 1. The digester may convert up to 60% of the organic solids into gas - the remaining 40 percent carbon dioxide with some small traces of other gases. The equipment required for production consists of the oxygen-free digester, gas collection device, input and output equipment and a controlled heat input system.

The system should be kept simple for small community or farm installations. Figure 2 shows a drawing of a simple manually operated continuous flow digester. The amount of gas produced depends on the digester size and the loading rate of the solids plus the temperature in the unit. Also, the composition of the feedstocks are important to production capacity.

The major use of this gas is at the production site. It does not lend itself to storage. The best uses are space heating, stationery engines, crop dryers and cookstoves. This means that confined livestock operations, like dairying and hog production, could benefit from the production of methane most efficiently.

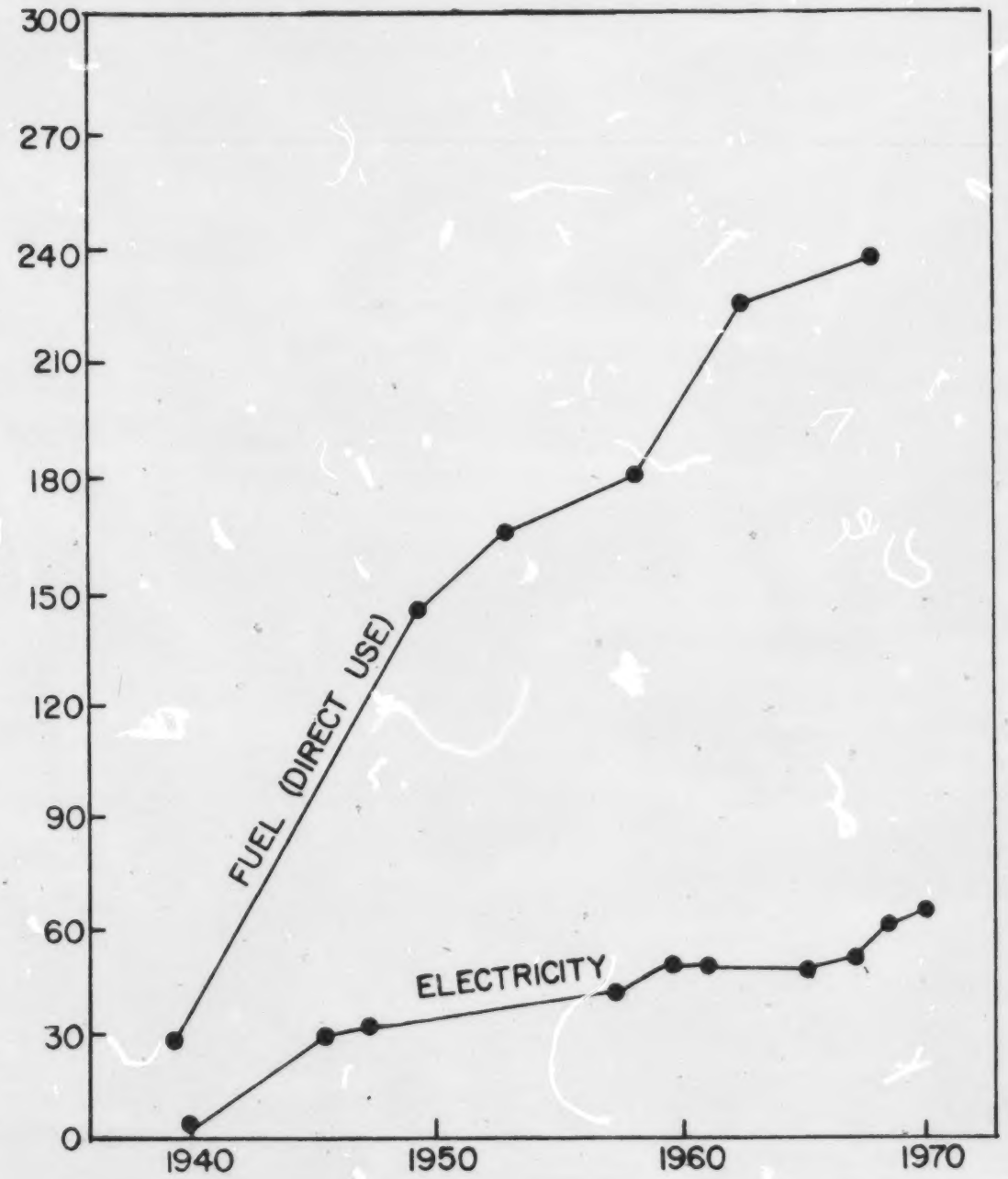
The production of ethanol by the the process of using products of starchy plants that can be fermented is important to fuel usage. The ethanol produced can be blended with conventional gasoline and

is presently being marketed throughout the United States as Gasohol. The production of ethanol from corn leaves the protein in the original corn in the DDG (distiller s dried grain) that can be used as cattle feed. If the process could be accomplished by use of solar or waste heat from other energy conversions, the cost of gasohol could be very economic. This assumption is based on the sale of DDG as feed and low cost renewal energy sources for conversion process to ethanol.

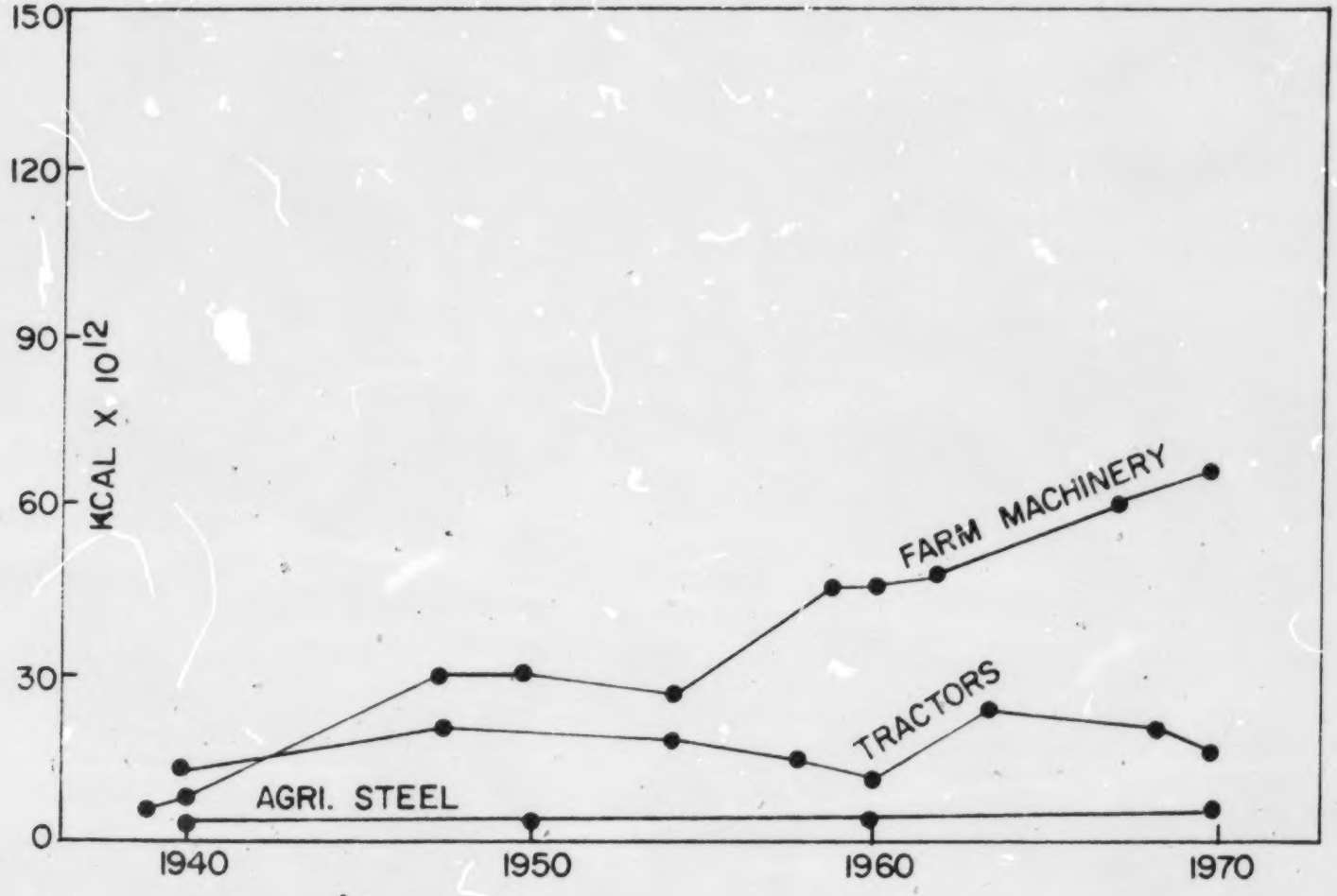
The remaining factor to consider in production agriculture energy use is the area of management. The aspects of management is important to all the areas previously mentioned: cultivation, equipment usage, land use, irrigation, fertilizers, chemicals, cropping and livestock practices, and alternative sources of energy, are not efficient unless well coordinated and used effectively. The purpose of management is to choose the proper alternatives and monitor their utilization. The key to saving energy first is understanding that it is people and their habits, not the devices they operate, that may waste the energy. Giving thought to the cost versus a better alternative in every aspect of farm operation could reduce the energy cost up to twenty percent or more.

A good example of management information is the energy tax incentives offered by local state governments and the federal government. Check your local area for regulations concerning benefits available in your state.

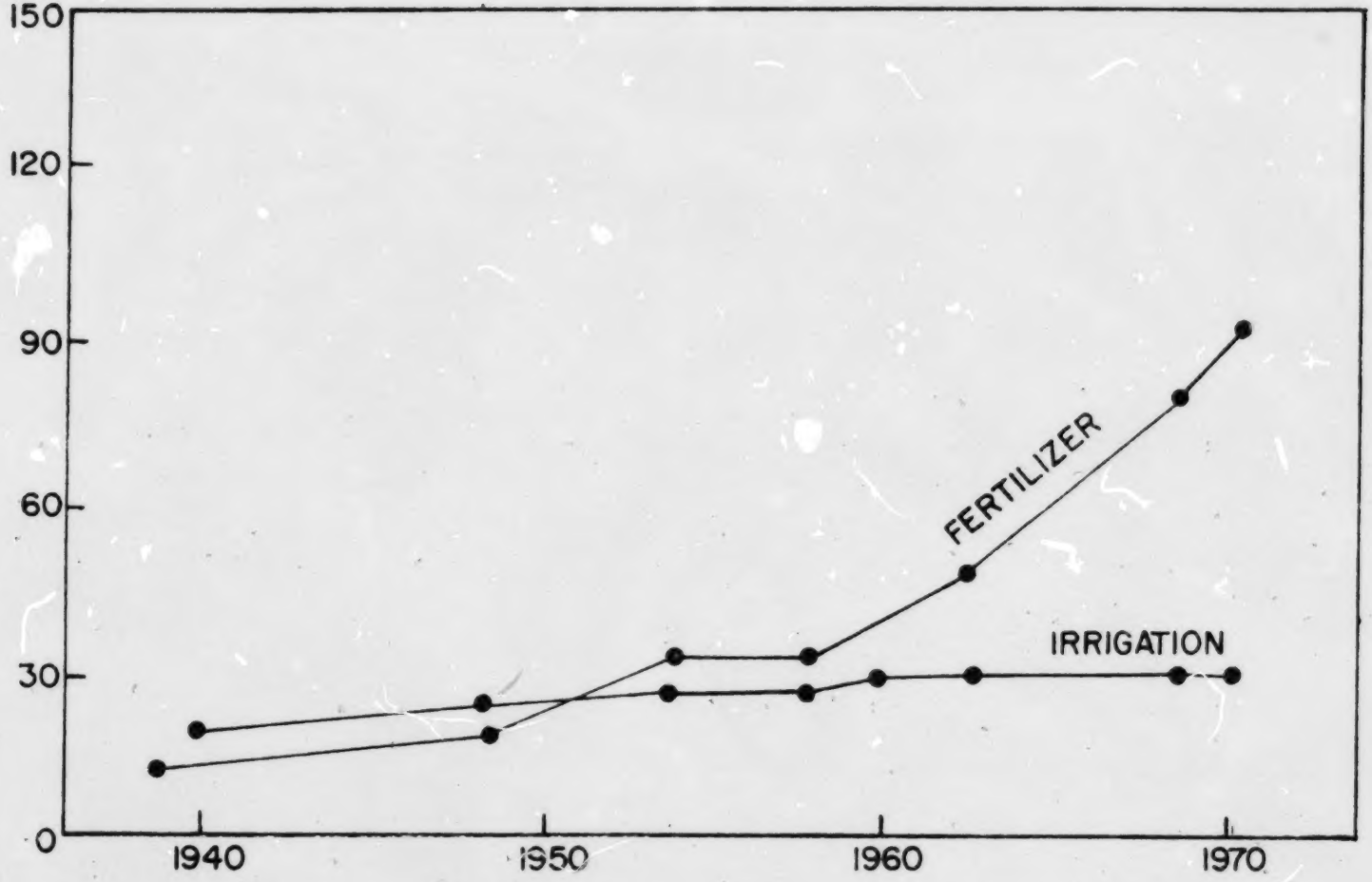
ENERGY USE ON FARMS 1970-1940



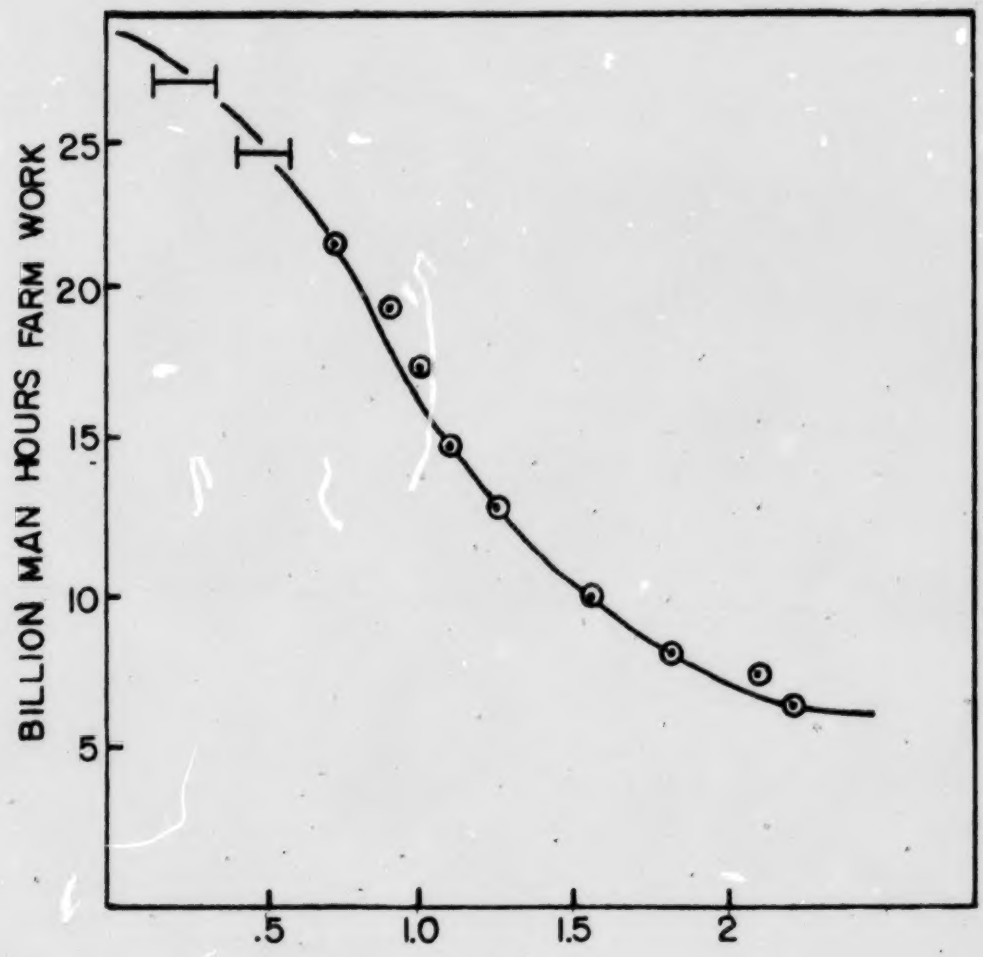
ENERGY USE ON FARMS, 1940-1970



ENERGY USE ON FARMS, 1940-1970



FARM OUTPUT AS A FUNCTION OF ENERGY INPUT



AGRICULTURAL ENERGY PRACTICES

TEST

I. Indicate the correct response to each statement by circling "T" for true and "F" for false in the statements below.

T F 1. Statistics indicate that less than 5% of United States population is engaged in agriculture production.

T F 2. During the past 50 years there has been an increase in farm labor.

T F 3. More than 50% of those persons engaged in agriculture also hold off-the-farm jobs.

T F 4. Photosynthesis conversion of energy is about one percent efficient.

T F 5. United States food exports amount to about 10% of gross farm products.

T F 6. Exports of United States farm products consist mainly of grain products.

T F 7. It is likely that further increases in food production from increasing energy inputs are the probable outcome.

T F 8. The statistics indicate that one United States farmer is now producing enough to feed 50 people.

T F 9. The substitution of technology and energy for labor in the future is expected to be less.

T F 10. The individual agriculture producer has little power to affect market prices by single actions.

T F 11. National income generated from agriculture exceeds total farm income itself.

T F 12. Government subsities account for very small amount of farm income in the United States.

T F 13. Farm income tends to lag behind national averages in increased amount of income.

T F 14. Nations with severe food shortages are frequently those with short supply of fossil foods.

T F 15. It takes less energy to produce high protein foods than to produce plant foods.

T F 16. Soybeans are considered as good potential source of future food because of their high protein content.

T F 17. Between five and ten calories of fuel are used to produce one calorie of food in industrialized food production.

T F 18. Farms with animal feedlots have a potentially useful alternative source of energy in manure accumulation.

T F 19. Solar use of energy is a relatively new practice of American farmers to provide a supplemental heat source.

T F 20. The use of biogas for operations on the farm that involve confined livestock production would be practical.

T F 21. Ethanol is produced by the fermentation process of starchy plants such as corn.

T F 22. Management factors contribute very little to the conservation of energy on the farm.

II. 23. Factors related to energy reduction in the United States food system were considered in this unit. Below are a list of possible factors. Indicate those which have possibilities in this respect by placing a check mark in the appropriate space.

_____ Use of chemical fertilizers.

_____ Legislation controlling competitive practices in packaging.

_____ Using more trucks for transport.

_____ Changing eating habits of population.

_____ More use of "natural" foods.

_____ Increasing energy prices.

_____ Recycling metal containers.

_____ More "frostless" freezers-refrigerators.

_____ Food supplied from coal, oil, and garbage.

24. Agricultural system measures are most often described in economic terms. Several economic terms were described in this unit. List four of those discussed.

A.

B.

C.

D.

25. Energy used directly on the farm is attributable to seven basic catagories. List four of those considered in this unit.

A.

B.

C.

D.

AGRICULTURAL ENERGY PRACTICES

TEST ANSWERS

I.

1.	T	12.	F
2.	F	13.	T
3.	T	14.	T
4.	T	15.	F
5.	F	16.	T
6.	T	17.	T
7.	F	18.	T
8.	T	19.	F
9.	F	20.	T
10.	T	21.	T
11.	T	22.	F

II. 23. Energy reduction in the United States food system factories include:

____ Use of chemical fertilizers.

✓ Legislation controlling competitive practices in packaging.

____ Using more trucks for transport.

✓ Changing eating habits of population.

✓ More use of "natural" foods.

✓ Increasing energy prices.

✓ Recycling metal containers.

____ More "frostless" freezers-refrigerators.

✓ Food supplied from coal, oil, and garbage.

24. Economic terms that measure agricultural systems include any four of the following:

A. Expenses

B. Dollar flow

C. Production amounts

D. Shipments

E. Income

F. Labor

25. Energy used directly on the farm is attributable to seven basic catagories. Any four of the following may be used.

A. Fuel (direct use)

B. Electricity

C. Fertilizer

D. Agricultural steel

E. Farm machinery

F. Tractors

G. Irrigation